

## **Adjustments to Current iLUC Values and other Changes Associated with Updated GREET Analyses and Data from the LCFS 2014 LRT Reports Used in the Updated Analysis of the LCFS Compliance Curve**

Ongoing work and the receipt of more recent data since the release of the LCFS Initial Statement of Reasons (ISOR) necessitate an update to the analysis of the LCFS Compliance Curve included in the ISOR. This paper brief describes what has been updated and, in Table 1 “Analysis of Compliance Curve with Greet 2.0 CIs and 2014 LRT Data”, presents the effect of these updates on credit generation.

While this update affects parts of the analysis, most of what was included in the ISOR has not changed. For example:

- The proposed compliance curve is the same as in the ISOR
- Sufficient credit generation is expected through 2025 to offset deficit production
- The amounts and mix of credit generating fuels used between 2015 and 2025 is the same as in the ISOR, and
- The gradual improvement in fuel CIs with time continues to be reflected in the analysis

The updated assessment now applies the carbon intensity (CI ) values derived from GREET 2.0 beginning in 2016, incorporates data on fuels and CIs entered into the Low Carbon Fuel Standard Reporting Tool (LRT) for all four quarters of 2014, reflects the use of the Low-Energy-Use Refinery provision and improves the method used to calculate credit generation from natural gas. Each of these subjects is discussed below.

### **1. Changes to CIs to Reflect GREET 2.0 Values**

#### **a. Changes to the CIs for CARBOB, CARB Diesel and CaRFG**

Recent work has resulted in minor changes to the CIs for CARBOB, CARB diesel and CaRFG from those modelled in the ISOR. These changes have relatively small impacts on the calculation of credit and deficit generation. The following values are used in the updated LCFS illustrative scenarios beginning in 2016:

- CI for CARBOB of 100.53 grams/MJ rather than 100.58
- CI for CARB Diesel of 102.76 grams/MJ rather than 102.82
- 2010 base CI for CaRFG of 99.11grams/MJ rather than 98.18

## **b. Changes to CIs to Reflect GREET 2.0 Values for other Fuels**

Fuel CIs for ethanol, hydrogen, electricity, renewable diesel, biodiesel, and natural gas have all been updated to make them consistent with the values derived from GREET 2.0. These revised values are applied in 2016, and are shown in Table 1.

## **c. iLUC Changes**

Indirect land use effects (iLUC) have been updated to reflect the values used in GREET 2.0 for several crop-based biofuels starting in 2016. The principal changes that are used were:

- The iLUC value used for corn-derived ethanol is 19.8 grams/MJ,
- The iLUC value for cane-derived ethanol is 11.8 grams/MJ, and
- The iLUC value for soy-derived biodiesel is 29.1 grams/MJ

These values are incorporated into the CI values shown in Table 1.

## **2. Changes to Reflect 2014 Data from the LCFS LRT**

New data from the LRT has become available since the LCFS ISOR was released. Most entities have now filed their reports for the fourth quarter of 2014. Staff used this data to modify the fuel volumes and average CIs used for 2014 in the analysis of the LCFS Compliance Curve. Fuel amounts were updated for all fuels but electricity<sup>1</sup>. The revised values are shown in Table 1. Overall credit generation in 2014 is about 0.75 MMTs lower than previously estimated while deficit generation was basically unchanged.

## **3. Changes to Improve the Credit Generation Estimates for Natural Gas**

Two changes in the methodology to calculate the credits from natural gas (NG) were incorporated into the updated analysis. These were:

- Inclusion of the use of NG by light and medium duty vehicles under the “gasoline” standard, and
- Application of the proper EER in the calculation of credit production when NG is used

Roughly 12 percent of the NG used in 2014 was in the light and medium duty vehicle category. Additionally the previous analysis failed to apply the 0.9 EER affecting credit

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<sup>1</sup> So far, the 2014 transportation electricity use reported in LRT does not include the 3<sup>rd</sup> and 4<sup>th</sup> quarters non-metered residential charging data from utilities. However, based on the filings for the 1<sup>st</sup> and 2<sup>nd</sup> quarters, the values used in the ISOR for 2014 are consistent with the expected use of electricity in 2014 and have been retained.

generation by heavy duty-spark ignition vehicles that use NG. The updated analysis corrects this issue.

The analysis was not modified in terms of future projections of overall NG use. It was assumed that there would be little growth in the use of NG in light and medium duty vehicles, and that use was kept constant through 2025. The volumes on NG used by heavy duty vehicles were adjust downward to reflect the amount used by light and medium duty vehicle.

#### **4. Changes to the Provisions for Low-Energy-Use Refiners**

The updated analysis estimates that this provision will decrease deficit generation by 0.15 MMTs per year starting in 2016. This reduction is now included in Table 1 in the estimate of refinery credits, which otherwise remain unchanged.

#### **5. Overall Impact of the Updated Analysis**

Annual credit production in is somewhat less in 2014 than in the previous analysis, and generally just slightly less thereafter until around 2020. However, while the amount of credits carried over is less there are ample credits trough 2020 and more credits than deficits available for the entire period from 2016 through 2020. The table below provides compares the credit balances at the end of each year in the ISOR analysis with those in the updated assessment. The detailed results are shown in Table 1.

**Million Metric Tons of Banked LCFS Credits at End of Year**

<b>Analysis</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>
<b>ISOR</b>	12.6	14.7	15.4	12.5	6.2	3.2	2.5	4.1	7.8	13.5
<b>Updated</b>	11.4	13.2	13.8	10.7	4.5	1.6	1.1	3.1	7.2	13.3
<b>Difference</b>	1.2	1.5	1.6	1.8	1.7	1.6	1.4	1.0	0.6	0.2

As previously stated, many other mixes of low CI fuels and innovative credit creation are possible, and the eventual mix of fuels used will be different from this assessment.

Table 1 -- Analysis of Compliance Curve With Greet 2.0 CIs and 2014 LRT Data

3-Apr-15	2010 Baseline CI		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	Gasoline Std	99.11	97.96	97.96	97.13	95.64	94.15	91.68	89.20	89.20	89.20	89.20	89.20	89.20
	Diesel Std	102.76	97.05	97.05	100.70	99.16	97.62	95.05	92.48	92.48	92.48	92.48	92.48	92.48
		CI Reduction	1.00%	1.00%	2.00%	3.50%	5.00%	7.50%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
	Gasoline Demand		14,433	14,324	14,181	14,039	13,899	13,760	13,622	13,418	13,216	13,018	12,823	12,630
	Diesel Demand		3,787	3,788	3,845	3,903	3,961	4,021	4,081	4,142	4,204	4,267	4,331	4,396
	Electricity Use - Mn MWh		0.2	0.4	1.5	1.7	1.9	2.2	2.5	3.0	3.5	4.0	4.7	5.3
Summary Results -----		MMTs of Cred	4.8	8.2	11.4	13.2	13.8	10.7	4.5	1.6	1.1	3.1	7.2	13.3
		Fuel Volumes Table												
	Biofuel	Units	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Corn Ethanol		mm gal	1,235	1,200	1,100	1,000	825	750	700	600	550	475	400	320
Cane Ethanol		mm gal	2	150	200	250	350	400	450	500	500	500	500	500
Sorghum/Corn Ethanol		mm gal	134	100	100	100	100	100	100	100	100	100	100	100
Misc Corn Ethanol		mm gal	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum/Corn/Wheat Ethanol		mm gal	49	50	50	75	75	75	75	75	75	75	75	75
Cellulosic Ethanol		mm gal	0	0	5	15	50	75	100	200	250	300	350	400
Molasses Ethanol		mm gal	6	20	40	40	60	60	60	60	60	60	60	60
Renewable Gasoline		mm gal	0	0	0	0	5	15	25	50	100	150	200	250
CNG in LDVs and MDVs		mm gal GGE	17	17	17	17	17	17	17	17	17	17	17	17
Hydrogen		mm gal GGE	0	0	1	2	4	5	7	10	13	16	21	27
Electricity for LDVs		1000 MWH	294	440	596	759	982	1,276	1,629	2,064	2,563	3,127	3,757	4,374
Total Ethanol			1,426	1,520	1,495	1,480	1,460	1,460	1,485	1,535	1,535	1,510	1,485	1,455
CARBOB (energy adjusted)			12,965	12,779	12,641	12,496	12,344	12,168	11,969	11,665	11,366	11,080	10,788	10,503
Gasoline As CARFG + E85			14,391	14,299	14,136	13,976	13,809	13,643	13,479	13,250	13,001	12,740	12,473	12,208
Ethanol			9.91%	10.63%	10.58%	10.59%	10.57%	10.70%	11.02%	11.59%	11.81%	11.85%	11.91%	11.92%
		Units	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Total Biodiesel		mm gal	65	97	129	160	180	180	180	185	185	185	190	190
Renewable Diesel		mm gal	114	180	250	300	320	360	400	500	550	600	600	600
Conventional Natural Gas		mm gal DGE	86	70	75	75	75	75	55	35	35	35	35	35
Renewable Natural Gas		mm gal DGE	23	55	70	90	130	170	230	290	330	370	410	450
Electricity for HDVs/Rail		1000 MWH	0	0	900	900	900	900	900	900	900	900	900	900
Total HD NG (DGEs)			110	125	145	165	205	245	285	325	365	405	445	485
Total Biodiesel (MM gal.)			65	97	129	160	180	180	180	185	185	185	190	190
Diesel (non-adjusted)			3,787	3,788	3,845	3,903	3,961	4,021	4,081	4,142	4,204	4,267	4,331	4,396
Diesel (energy adjusted)			3,506	3,399	3,314	3,274	3,255	3,236	3,217	3,137	3,111	3,086	3,106	3,130
Total biodiesel %			1.76%	2.64%	3.49%	4.28%	4.79%	4.77%	4.74%	4.84%	4.81%	4.78%	4.88%	4.85%
Renewable Diesel %			3.09%	4.90%	6.77%	8.03%	8.52%	9.54%	10.53%	13.08%	14.30%	15.50%	15.40%	15.30%
		Average Annual - CI Assumptions for Each Fuel (g/MJ) (Revised in Draft 3-25-2015)												
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	Corn Ethanol		83	83	70	69	67	66	65	64	63	62	61	60
	Cane Ethanol		58	70	44	44	43	43	42	42	41	41	40	40
	Sorghum/Corn Ethanol		79	79	70	69	67	66	65	64	63	62	61	60
	Misc Corn Ethanol		88	88	70	69	69	68	67	67	66	65	65	64
	Sorghum/Corn/Wheat Ethanol		65	65	65	64	64	63	62	62	61	61	60	59
	Cell. Ethanol		20	20	20	20	20	20	20	20	20	20	20	20
	Molasses Ethanol		23	23	33	33	36	36	36	35	35	35	34	34
	Renewable Gasoline		35	35	35	35	35	35	35	35	35	35	35	35
	Hydrogen EER Adj.)		44	44	42	40	37	35	32	32	32	32	32	32
	Electricity for LDVs (EER Adj.)		30	30	31	30	29	28	26	26	26	26	26	26
	Avg Biodiesel CI		20	20	20	20	19	19	18	18	17	17	16	16
	Renewable Diesel		35	35	30	30	30	30	30	30	30	30	30	30
	Avg of CONV. LNG&CNG		71	71	78	78	78	78	78	78	78	78	78	78
	Renewable NG		29	20	20	20	20	19	19	19	19	18	18	18
	Electricity for HDVs/Rail (EER Adj.)		35	35	35	34	33	32	29	29	29	29	29	29
	CARBOB		99.18	99.18	100.53	100.53	100.53	100.53	100.53	100.53	100.53	100.53	100.53	100.53
	CARB Diesel		98.03	98.03	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76
		MMTs of Credits or Deficits												
	Biofuel		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	Corn Ethanol		1.476	1.434	2.432	2.172	1.826	1.570	1.381	1.232	1.175	1.053	0.919	0.762
	Cane Ethanol		0.008	0.346	0.866	1.063	1.459	1.603	1.731	1.944	1.964	1.985	2.005	2.025
	Sorghum/Corn Ethanol		0.211	0.157	0.221	0.217	0.221	0.209	0.197	0.205	0.214	0.222	0.230	0.238
	Misc Corn Ethanol		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Sorghum/Corn/Wheat Ethanol		0.130	0.134	0.134	0.195	0.190	0.179	0.184	0.187	0.191	0.195	0.199	0.202
	Cellulosic Ethanol		0.000	0.000	0.031	0.092	0.302	0.438	0.564	1.128	1.410	1.692	1.974	2.256
	Molasses Ethanol		0.034	0.123	0.208	0.204	0.283	0.273	0.262	0.264	0.266	0.267	0.269	0.271
	Renewable Gasoline		0.000	0.000	0.000	0.000	0.035	0.102	0.162	0.324	0.648	0.972	1.296	1.620
	CNG in LDVs and MDVs		0.08	0.09	0.12	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10
	Hydrogen		0.001	0.006	0.013	0.033	0.067	0.101	0.134	0.185	0.235	0.302	0.386	0.503
	Electricity for LDVs		0.244	0.365	0.483	0.611	0.784	0.996	1.260	1.597	1.983	2.419	2.906	3.383
	Total Gasoline Side Credits		2.186	2.656	4.505	4.701	5.281	5.577	5.978	7.169	8.188	9.210	10.288	11.365
	CARBOB Deficits		-1.891	-1.864	-5.141	-7.303	-9.408	-12.877	-16.212	-15.800	-15.395	-15.007	-14.613	-14.226
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	Biodiesel		0.633	0.948	1.313	1.608	1.785	1.738	1.691	1.750	1.761	1.773	1.833	1.845
	Renewable Diesel		0.917	1.448	2.292	2.690	2.806	3.036	3.240	4.051	4.456	4.861	4.861	4.861
	Conv. Natural Gas		0.20	0.16	0.13	0.11	0.10	0.08	0.04	0.02	0.02	0.02	0.02	0.02
	Renewable NG		0.18	0.50	0.66	0.84	1.19	1.51	1.98	2.51	2.87	3.24	3.60	3.97
	Electricity for HDVs/Rail		0.000	0.000	0.213	0.211	0.210	0.206	0.204	0.204	0.204	0.204	0.204	0.204
	Total Diesel Side Credits		1.929	3.053	4.607	5.461	6.092	6.568	7.158	8.542	9.318	10.098	10.525	10.906
	Diesel Deficits		-0.462	-0.448	-0.916	-1.584	-2.249	-3.353	-4.446	-4.335	-4.299	-4.265	-4.291	-4.326
	Annual Credit Balance		1.762	3.398	3.205	1.875	0.541	-3.035	-6.247	-2.924	-0.463	1.987	4.083	6.119
	Refinery Credits		0.000	0.000	0.15	0.60	0.83	1.05	1.28	1.50	1.73	1.95	2.18	2.40
	Total Credits		4.115	5.709	9.262	10.762	12.197	13.196	14.411	17.211	19.232	21.259	22.987	24.671
	Total Deficits		-2.353	-2.312	-6.057	-8.886	-11.656	-16.230	-20.658	-20.135	-19.694	-19.272	-18.904	-18.552
			4.76	8.16	11.36	13.24	13.78	10.75	4.50	1.58	1.11	3.10	7.18	13.30